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IE Tools in Construction - Small Tools Spreadsheet

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IE TOOLS IN CONSTRUCTION – SMALL TOOLS SPREADSHEET

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by
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ABSTRACT

This document will explore the development and implementation of a spreadsheet tool that will provide for effective planning, procurement, and management of "small tools" on a construction site – small tools are relatively inexpensive items that are usually handheld. The following five chapters cover the development of the spreadsheet. Both methodology and the calculation process are explored in detail and all facets of the spreadsheet are explained. A key component of the development process is that end users were involved in the entire development process to ensure the spreadsheet met their needs.

In general, users input several criteria regarding work for different disciplines. From these inputs the spreadsheet creates appropriate tool distributions over the duration of the project. Users are able to select an appropriate distribution from a list as well as customize the spreadsheet to better fit their practices. This document concludes with suggestions for revision and future development of this spreadsheet tool.

ACKNOWLEDGMENTS

I would like to thank Rick Montgomery and Donnie Chapman of Progress Energy and Day and Zimmerman, respectively for their help with the small tools spreadsheet and vendor tool lists. I would also like to thank Dr. Steve Sanders of the Clemson University Department of Civil Engineering and Dr. Bill Ferrell for serving on my committee and guiding me through the spreadsheet project. Finally, I would like to thank Dr. Leidy Klotz for also serving on my committee.

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CHAPTER ONE

INTRODUCTION

This document explains the development of a small tools spreadsheet to aid in the planning, procurement, and management of small tools on construction sites. In this context, “small tools” refers mainly to handheld tools that are required on most construction sites. As all construction projects are different, there is no standard set of these tools that will fit all of them. However, items such as grinders, chisels, hammers, and wrenches will appear on most all construction sites, particularly those in the industrial sector. Small tools can generally be carried by one person and usually cost less than $500. This will be the convention for this document and the small tools spreadsheet.

Although most would consider small tools expendable, the quantity used on most construction projects is enough that significant amounts of money can be saved by effectively managing them. In the past, the procurement and management of small tools was the responsibility of a person or persons involved in project management. As there was no set method to plan and manage these tools, everyone did it a little bit differently. Personal experience, common sense, individual judgment, and to some extent historical data were all used to decide on which and how many of these tools should be purchased. Many times, this method was little more than an educated guess as to how many tools would be required over the project’s duration. This almost always led to too many items being purchased or running out of a particular tool during the project. Also, since many tools are not all purchased at the beginning of a project, reorders must be done throughout the project. The amount of tools on these reorders was again little more than a guess.

There should obviously be a better way to determine these tool requirements. Although these ineffective methods have sufficed in the past, companies could have saved significant sums of money over the years if they had efficiently managed these small tools.

There are currently no means to provide for the planning, procurement, and management of small tools through all stages of a project and match the demand to the appropriate distribution. Here arises the niche for a way to effectively manage these small tools. A single tool that would accomplish these goals would prove invaluable in the construction field if designed in such a way to produce accurate and reliable results and allow for manipulation to better-fit specific projects.

Considering the nature of this problem, an electronic solution would be desirable. Also, having this solution on a computer would make the tool more likely to be utilized by today's professionals. Microsoft Excel provides a platform that is near perfect for this application. Most professionals in the fields of engineering and construction have ready access to Microsoft software, specifically Excel, and are at least somewhat familiar with it. Also, Excel makes it easy to input and manipulate data and print desirable outcomes. The goal of this project is to provide a user-friendly Excel based tool that will provide a plan for the purchasing and management of small tools with a limited number of user inputs.

CHAPTER TWO

LITERATURE REVIEW

As there has been limited research in the area of IE applications in construction, it is not a surprise that a tool to manage small tools has not been created. Similarly, the idea of using Microsoft Excel to model tool requirements has not seen research either. That makes this spreadsheet tool completely new research, which drastically changes the nature of this document.

It is important to note that this "research project" is not really research at all. Whereas most traditional research projects involve a great deal of literature review, this scenario does not call for that. Since there is effectively no pertinent material to review, most of the research here is in the development and testing of the small tools spreadsheet. Research is the customary word to refer to this kind of work, so that term will be used in this document also, for convenience. There has definitely been research taking place throughout this project, however, even if it is not the traditional type. Investigation would probably be a better term for the methods used to develop this spreadsheet, as trial and error and suggestions from others have shaped the final product more than anything else.

The first version of the small tools spreadsheet, an example from a previous project on which the companies had worked, came from two individuals working for two separate companies. This example served as a very basic version of the final product. The ideas and some of the calculations were present in that first version, but the tool was not user friendly. In fact, the majority of people that looked at that spreadsheet would probably not even know what it was. It was designed for and used by experienced

professionals in dealing with tool procurement and management. The sheet was not generic and did not allow for modifications. Regardless, the spreadsheet had the makings of a very useful tool. This is not to say that the final product obtained was just a newer version of the original spreadsheet. This new version is completely stand-alone and merely incorporated some of the same mathematical processes and ideas of the distributions.

CHAPTER THREE

METHODOLOGY

This section describes the process used to develop the small tools spreadsheet. The objective was to develop a tool that could use standard tool lists for specific disciplines to calculate the discipline's tool needs over the life of the project and accurately distribute them across the working period of that discipline. This tool was to be user friendly and very intuitive, even to someone with limited computer knowledge. Microsoft Excel was selected to develop this tool for several reasons. First, most construction management professionals have access and some familiarity with the program. Also, Excel is inherently user friendly and a great deal of help and troubleshooting advice exists both electronically and in print. Moreover, few programs can match Excel in its ability to manipulate and manage data and create easy-to-use user inputs. All in all, a comprehensive Excel spreadsheet fit the bill perfectly for the development of the small tools management tool. When completed, this tool would stand on its own needing no inputs from any other source except its end user.

With the scope and basic ideas of the small tools spreadsheet defined, the task shifted to figuring out exactly how this spreadsheet would function. Key elements were defined for three basic portions of the spreadsheet: user inputs, calculations, and final outputs. Many facets exist in these three categories and their number had to be limited to maintain the simplicity of the tool.

User inputs are one of the most important components of the spreadsheet. The key is to have enough input to make the results logical and accurate, yet stay simple enough

to maintain the user's interest and comfort level. In the early stages, the inputs of the spreadsheet were numerous and simplicity was sacrificed. Through some experimentation and opinions of the research team, these inputs were condensed to a reasonable number while maintaining the accuracy of the tool.

To use the spreadsheet, the user inputs several parameters for the work to be done by each of six predefined disciplines.

1. **Boilermakers** are craftsmen that fabricate steel and other metals in a variety of applications including but not limited to boilers and furnaces.
2. The **Civil** discipline deals with the individuals doing grading and site work. Drainage is also included in this discipline.
3. **Instrumentation/Electrical** craftsmen deal with electronic and electrical components of a project. This often includes wiring and the installation of various instruments.
4. **Millwrights** are craftsmen trained to construct and maintain machinery.
5. The **Piping** discipline deals with all aspects of the installation of piping for any reason it may exist on the project. It generally deals with metal piping for steam, water, pressurized air or other gasses as opposed to drainage pipes.
6. **Structural steel** deals with the fabrication and erection of the structural steel components of the structure itself.

The user inputs four parameters for each discipline – total work hours, start date, end date, and appropriate distribution. The work hours referred to here are the total number of work hours (the term "man hours" is still used by many) needed for each discipline to

accomplish their portion of the work. These work hours are assumed to take place uninterrupted between the start and end dates of that discipline's work.

Work hours are distributed over the duration of each discipline's work according to a user-specified distribution. Four distributions are available in the form of a drop-down menu. Although Excel has many statistical distributions, these distributions most accurately model the work hour progression through each discipline's duration. The four distributions are:

1. Normal distribution
2. Beta 1 distribution (referred to as "Semicircle" in the spreadsheet)
3. Beta 2 distribution (referred to as "Front-end loaded" in the spreadsheet)
4. Uniform distribution (referred to as "Flat" in the spreadsheet)

These provide the user with the ability to tailor the allocation of work hours to their specific project and its work distribution. For those not familiar with these statistical functions, a diagram appears below the input template that shows the graphs of the four distributions (see Figure A-5). A simplified explanation of the distributions and the entire input template appears in the instruction manual to the spreadsheet (see Figure B-1).

The Navigation Page provides easy access to all parts of the spreadsheet. As in any multi-page spreadsheet in Excel, tabs label each sheet along the bottom. The tabs in the small tools spreadsheet are labeled to show their contents. Users can navigate the spreadsheet with the Navigation Page or the tabs directly. Either way yields the same results. More advanced users are likely to use the tabs because of familiarity (see Figure A-3). The spreadsheet opens to the top of the Navigation Page to help users understand

the process of filling out the spreadsheet. The Navigation Page contains hyperlinks to various parts of the spreadsheet including the User Input page (see Figure A-4). These links will take users directly to each of the six disciplines to fill out their respective parameters. Other links go to the remaining user inputs for the entire project. Also, links exist to take users to the output sheets after the calculations have taken place. All the linked pages contain links to direct users back to the Navigation Page.

As mentioned above, several user inputs exist for the project as a whole, not specific to any discipline. Working hours per day and working days per week are the first two. The spreadsheet defaults to 10 work hours per day and 5 working days per week, but users can change these values at any point while using the spreadsheet. The cells are referenced absolutely so users can actually see the impact of altering their work schedule on tool requirements.

A multiplication factor is the next input. This factor accounts mainly for the theft of and damage to small tools. As any professional with field experience knows, many tools are damaged or stolen during a project, especially projects with a high number of handheld tools. The default value of the multiplication factor is 1.5. In this case, that means the number of tools for each discipline is increased by 50% to yield the actual project requirements. This actual value will be different on most projects and must be determined based on experience and/or historical data. Since the multiplication factor has such a great impact on the tools required, careful attention should be taken to maintain its accuracy. Also, the cell in the spreadsheet is absolutely referenced, so it can be adjusted at any time and tool requirements will update automatically.

The final two inputs on the input sheet are the start and end dates for the entire project. These dates are used to populate some of the calculation pages of the spreadsheet and are not as crucial to the number of tools required as the other inputs. Users should always input them properly, however, as the accuracy of the tool distributions will be affected if all dates are not kept consistent. Users should always keep that in mind that the accuracy of the spreadsheet tool is completely dependent upon the accuracy of the input data.

After all user inputs are complete, the spreadsheet's calculation process can take place. To recap, the spreadsheet essentially distributes predefined (or user defined) tool lists over the appropriate working period for each of the six disciplines. The shape of that distribution is defined by the user on the User Inputs sheet. The four available distributions will be discussed in greater detail later in this document. For example, the Piping discipline's standard tool list is shown in the Piping Tool List sheet. Standard tool requirements are built in to the spreadsheet, but users can edit them in the Piping Tool List sheet or whatever discipline is desired. If someone wished to increase or decrease the number of a particular tool required by the Piping discipline, or eliminate the tool altogether, that is accomplished by editing the standard tool lists. Again, links exist on the Navigation Page to help unfamiliar users with this task.

Calculations take place automatically when users input their project information. Outputs already exist in the spreadsheet; the number of tools required is simply populated in the existing cells. The spreadsheet contains seven predefined outputs representing different facets of the overall tool requirements for the project. A sheet exists for the tool

requirements for each of the six disciplines. It shows the number of tools required, by month, over the duration of the project. A consolidated tool list is also present that sums the tool requirements for all six disciplines for a comprehensive tool list, by month, for the entire project. As with all parts of the spreadsheet, the Navigation Page provides an easy means to access all these sheets via hyperlinks. Similarly, each output sheet has a hyperlink at the bottom of the page directing the user back to the Navigation Page.

There are a great number of other considerations that must be accounted for to make this spreadsheet useful, user-friendly, and accurate. One of the most important aspects of the spreadsheet is the ability to use different tool distributions to match individual project requirements. No two projects are exactly alike and similarly, no two projects' tool requirements will be either. Tool requirements will be distributed differently in all construction projects. However, the number of available distributions must be limited to create this spreadsheet tool. After extensive discussion, it was decided that most all projects would approximately fit one of four possible distributions. Users select one of the four from a dropdown menu on the User Inputs sheet. The four distributions appear to users as:

1. Normal distribution
2. Semicircle distribution (Beta 1 distribution)
3. Front-end loaded distribution (Beta 2 distribution)
4. Flat distribution (Flat distribution)

Three of these four names are not technically the correct statistical name for their respective distributions, but they make more sense to someone with limited experience

with statistics. These four distributions are technically 1) Normal distribution, 2) Beta 1 distribution, 3) Beta 3 distribution, and 4) Uniform distribution. These names are the actual statistical reference in Microsoft Excel and are consistent with general knowledge in statistics. Several knowledgeable individuals were asked about appropriate distributions for this spreadsheet and the four listed above were finally decided upon. The fact is that none of these distributions, or any standard distribution for that matter, can exactly model the tools required on a project. Also, if a distribution was accurate for one project, there is a high likelihood that it will not match exactly with other projects, no matter how similar they may be. However, this spreadsheet tool is meant to provide for the planning, procurement, and management of small tools. This does not require a "perfect distribution", but rather a reasonable estimate of the average tool needs over the project's duration. For this reason, the spreadsheet's four available distributions will serve their purpose just fine. There is a graphic on the User Inputs sheet that shows the four distributions and their shapes (see Figure A-5).

Recalling, the four distributions are normal, beta 1, beta 2, and uniform. The preset for the spreadsheet is the normal distribution, and it is likely that this will be the most utilized. The standard normal distribution is very important to statistics. It is essentially a bell-shaped curve that is symmetrical about its mean. As this document is not statistics-related, no further explanation of the normal distribution is warranted. It is safe to say, however, that the normal distribution will provide a somewhat accurate representation of tool requirements in most situations. The important thing to take from the normal and any of the other three distributions is its shape. The bell shape is applied

to the tool requirements to create the tool distributions over time. The inherit problem with using the normal distribution is the fact that the tool requirements are far greater in the center of the duration than in the beginning or near the end. In reality, the normal distribution is a little extreme in that regard and that should be kept in mind. Using this distribution would cause a contractor to obtain a great number of tools over a short amount of time right before the peak of the work. Also, those tools would no longer be needed right after that peak took place. Although the normal distribution is somewhat relevant, a more realistic distribution would probably be the semicircle.

The second available distribution is the semicircle/beta 1 distribution. It appears to the user as "Semicircle" distribution because of its semicircular shape. This shape needs little explanation here, as it is simply a symmetrical half circle. This distribution will also accurately represent the tool requirements much of the time. Both the beta 1 and normal distributions are safe to assume in cases where the actual tool requirements are not known. It is likely that the tool requirements on a project will gradually increase with time to a point, and then gradually decrease until the work is completed. This is modeled best by the shape of the semicircle and to a lesser extent that of the normal distribution.

The third distribution is the front-end loaded/beta 2 distribution. This appears to users as "Front-end loaded". It is still a somewhat semicircle, but the maximum height is achieved close to the beginning of the distribution. In terms of tool requirements, this shape would indicate that more tools would be needed early on in the working period and less towards the end. This should be used when most resources are used at the early stages of the project. Many companies, having no means to accurately predict the tool

requirements, will procure tools in a manner consistent with this distribution. Some project managers will tend to buy the majority of the required tools at the beginning of a project so they will be available when needed. This is especially the case when storage space is of no concern. While this is not the most effective way to procure small tools, it has proven successful on projects for many years.

The forth and final available distribution is the uniform/flat distribution. It appears to users as "Flat" because of its shape. The shape of this distribution would indicate that tools are required at the exact same rate through the entire duration of the work. In some projects, this might be accurate. This would cause a contractor to purchase most all the tools to be used on the project and keep them available throughout its duration. Besides a drastic increase in the very beginning of the project, the tool requirements stay at a constant level all the way until the end of the work.

Users of this spreadsheet tool should have enough knowledge of their work environment to know which of the four distributions best suits their needs. It is important to note that the user selects distributions for each of the six disciplines individually. Different work crews have different tool needs over time and this option accounts for that.

Aside from the distributions, there are several other important considerations in the spreadsheet, most dealing with the spreadsheet's quality of being user-friendly. This was one of the most important ideas behind the spreadsheet tool. No matter how accurate and comprehensive a tool like this may be, it will never see its full potential and

usefulness unless it is easy to use. Again, the purpose here is to provide a user friendly Excel based tool.

When designing the spreadsheet, one of the first things to be decided on was the user's level of sophistication, especially with Excel. As outlined in the instruction guide (see Figure B-1), the spreadsheet tool can be used in two different ways, based on user sophistication. The "out of the box" version of the spreadsheet will have some of its capabilities locked. That is, users will not be able to change certain parts of the sheet to fit their needs. For users with minimal experience in Excel or with small tools management, this would be an appropriate option.

However, by simply saving the spreadsheet to one's own computer, the locks can be removed, allowing users to edit different items, for example the standard tool lists. This can only be done if users save their own copy of the spreadsheet to their computers. This higher level of sophistication is applicable to those with prior experience with this particular spreadsheet or those who have more extensive knowledge with Excel and/or the management of small tools. This option gives those users the ability to tailor the spreadsheet to their particular company and their individual projects, further adding to the effectiveness of this tool. Also, these users can view the calculation process that is hidden in the standard form of the spreadsheet.

Another aspect of making this spreadsheet user-friendly is having intuitive inputs and logical outputs. The goal is for users to see how the information they provide is processed and the outputs it provides. The most comfortable users are with the calculation process, the more likely they are to fully utilize this tool. This was

accomplished by creating easily followed inputs on the User Inputs sheet and easy to read outputs on the various output sheets. These outputs are nicely packaged and pre-formatted so users can easily use them immediately. The entire spreadsheet was designed to be as concise and accurate as possible to gain users' trust and approval.

A final aspect of the spreadsheet's effectiveness is perhaps the most significant. The Navigation Page was created to make the spreadsheet tool easier to use for all users. As mentioned earlier, the Navigation Page provides links to and from all the appropriate pages of the spreadsheet. It also, however, provides a simplified set of instructions for using the spreadsheet tool. If a user opens the small tools spreadsheet, the Navigation Page is the first thing they see. In fact, the cell that is already highlighted gives simplified instruction regarding the procedure of completing the spreadsheet. If users follow the spreadsheet in order, it is likely that they would properly utilize the spreadsheet tool the very first time they used it, even without prior knowledge of its characteristics. The Navigation Page makes it very simple to navigate through the entire spreadsheet and back with just a few clicks. Its addition to the spreadsheet was probably the single most important step in assuring the tool being user-friendly. A screenshot of the Navigation Page can be found in Appendix A (see. Figures A-1 and A-2).

CHAPTER FOUR

RESULTS

After all was said and done, the final product of this research turned out as well as could be expected. The final version of the spreadsheet accomplishes all goals set forth earlier in the project. Although extensive testing has not yet been conducted with those in the industry, several individuals in the research team have dealt with the spreadsheet enough to affirm its accuracy. Those who made the spreadsheet happen have agreed that all objectives were accomplished.

An important part of the further refinement of the spreadsheet tool is trials by industry experts and others in academia. Because of time and deadline limitations, this was not able to take place before the creation of this document. However, several individuals will have a copy of the spreadsheet in the near future for them to critique. Their opinions will further align all parts of the spreadsheet and make the final product that much more user friendly.

Along with others' suggestions, a few other changes have already been foreseen before the final spreadsheet product is produced. A few nuances still exist in the current version of the spreadsheet, most of which deal with automatic population of cells and making printing easier and more concise. Most all these issues will be resolved using macros. One criteria set by the team early on was that the spreadsheet would be easy to view and to print. The viewing part has already been accomplished but more work needs to happen in the printing area. The goal is to have pre-formatted print areas set in the default spreadsheet that will adjust themselves based on work duration and number of

tools required. This will take some more time and likely the development of more macros. Some of the programming issues, advanced macros for example, were beyond the scope of this portion of the project. However, the framework for the final spreadsheet already exists and other team members are able to finish off these last few issues.

Besides these few nuances, other issues will likely arise when more individuals begin testing the spreadsheet. Hopefully, these will all be small issues and will be easy to resolve. In the construction of a tool such as this one, all details can never be completely resolved until a great deal of time has been spent testing the tool. At that point, the spreadsheet defined in the scope of this project will be functioning as near perfect as possible.

Looking back, things could have been done differently during the development of the small tools spreadsheet. Since several individuals were involved in the construction of the spreadsheet tool, coordination and timing of submittals could have been more efficient. Perhaps more could have been done to the spreadsheet, especially testing, if the final product had been reached a month earlier or more. It is likely that the few remaining nuances could have already been resolved and some testing could have already taken place. It is important to keep in mind that this spreadsheet tool was essentially the first of its kind. Since nothing like it had been built by anyone, the entire experience was a learning process for everyone involved. Overall, the spreadsheet project was a success, providing a brand new tool to be used in many small tools management applications.

CHAPTER FIVE

CONCLUSIONS AND FUTURE WORK

Although the development of the small tools spreadsheet was a learning process through all its stages, the spreadsheet turned out very well. Overall, all objectives were met and the tool is very effective. Basically, the spreadsheet turned out to accomplish everything it was intended to. User friendliness was always maintained and all calculations took place when and how they were supposed to. The overall simplicity of the spreadsheet was also maintained throughout its development both in looks and functionality. Automatic population and layout were also achieved. All these and other factors create the overall effectiveness of the tool.

In regards to lessons learned, a few things should have probably been done differently in the development of the spreadsheet. As is the case in many projects, scope is not fully defined until a ways through the work. That was the case here, as the actual specifics of the spreadsheet tool were not fully defined until nearly half way through this portion of the research. Had the team known exactly what it was aiming for earlier on, more could have been done with the spreadsheet in the time given. Also, a computer expert was assigned to the project later on during the spreadsheet's development. Had this individual been available during the entire process of developing the tool, the entire thing would have gone much more smoothly. Many of the limitations of the tool are due to Excel and the limited Excel knowledge of the research team. The computer expert was able to bypass most of these limitations or at least provide partial solutions. This person has the knowledge to manipulate Excel much more effectively than those who put most

of the spreadsheet together. In the end, however, the computer expert was able to resolve almost all issues in the given time. Still, more could have been done earlier, as with many parts of this project.

Since this spreadsheet was the first of its kind, it will provide the groundwork for more in-depth and comprehensive programs to be built later on. The basic idea of the spreadsheet – taking defined tool lists and accurately distributing them over the duration of a project – was the most important accomplishment of the spreadsheet tool. Although the spreadsheet definitely accomplishes this goal, it can be expanded to provide even more tool management opportunities. For one, this idea does not have to be limited to small tools. Other construction tools and equipment could also apply, as long as their distributions could be accurately modeled. Materials and consumables could also be planned and managed this way, with minimal alteration to the spreadsheet. Although laborers are surely not tools of any sort, a process similar to that in the small tools spreadsheet could manage individual workers. The same principles apply to all these examples as well as many others.

Staying with the idea of managing small tools, this spreadsheet tool could be taken by another team and formed into something even more useful with greater accuracy. If the current framework was maintained, more detail and user inputs could be added to further tailor the spreadsheet to individual projects. For example, more distributions could be added to better match a project's requirements. More options could be made for users including the selection of disciplines and crew mixes. More than one standard set of tools for each discipline could be added as well. For example, a power

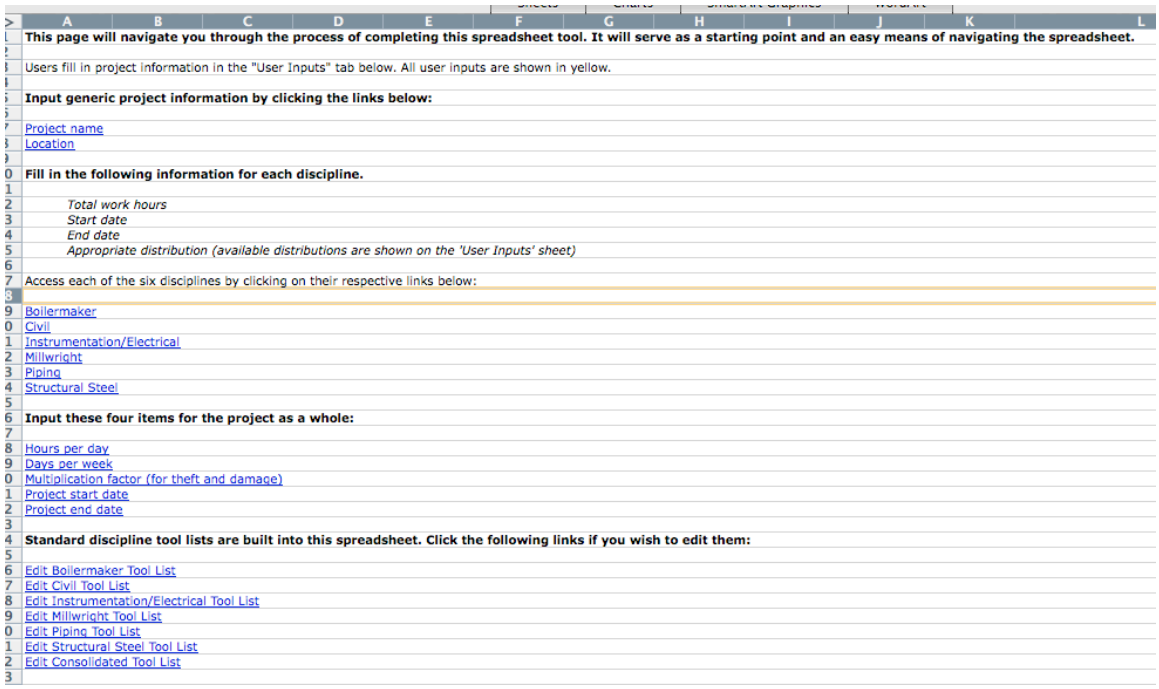
plant type project might warrant a specific set of tool lists and a manufacturing facility might warrant a completely different set. More options could be added to the calculation processes as well. For example, a tool manager might want to see a more specific breakdown of the tool requirements than by month. One may desire to see them by week and that option could be created. All these add to the required user sophistication and familiarity with the spreadsheet, which was generally avoided. The purpose of this spreadsheet was to provide a simplistic model of the too requirements to give manager something to go on while maintaining a low level of required sophistication, especially with technology.

A final path this spreadsheet could venture down would be the use of computer programs besides Excel or the spreadsheet being linked to one such program. If a simple computer program could be written such that users input simple parameters, similar to the ones in the User Inputs sheet (see Figure A-4), in a non-Excel program, it would allow more individuals to use the spreadsheet's capabilities, even if they were not comfortable with Excel. Ideally, those inputs could be entered, Excel or some other programs could perform the calculations in the background, and the program could provide easy to read outputs – tools over time. This will involve a great deal of development, which was out of the scope of this project. Although this alternative seems very effective, it limits the user's ability to edit tool lists and other specifics, all of which must be taken into consideration. Excel is likely the best platform to build such a tool, and that is why it was used for this project.

APPENDICES

Appendix A

Screenshots from the Small Tools Spreadsheet



This page will navigate you through the process of completing this spreadsheet tool. It will serve as a starting point and an easy means of navigating the spreadsheet.

Users fill in project information in the "User Inputs" tab below. All user inputs are shown in yellow.

Input generic project information by clicking the links below:

Project name
Location

Fill in the following information for each discipline.

Total work hours
Start date
End date
Appropriate distribution (available distributions are shown on the 'User Inputs' sheet)

Access each of the six disciplines by clicking on their respective links below:

Boilermaker
Civil
Instrumentation/Electrical
Millwright
Piping
Structural Steel

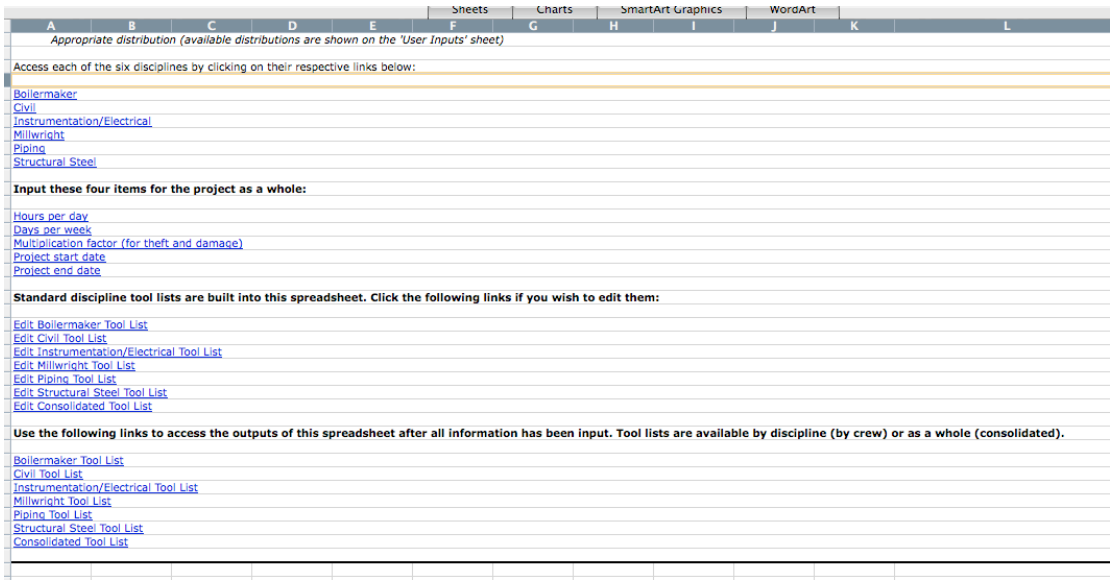
Input these four items for the project as a whole:

Hours per day
Days per week
Multiplication factor (for theft and damage)
Project start date
Project end date

Standard discipline tool lists are built into this spreadsheet. Click the following links if you wish to edit them:

Edit Boilermaker Tool List
Edit Civil Tool List
Edit Instrumentation/Electrical Tool List
Edit Millwright Tool List
Edit Piping Tool List
Edit Structural Steel Tool List
Edit Consolidated Tool List

Figure A-1: Top of Navigation Page



Appropriate distribution (available distributions are shown on the 'User Inputs' sheet)

Access each of the six disciplines by clicking on their respective links below:

Boilermaker
Civil
Instrumentation/Electrical
Millwright
Piping
Structural Steel

Input these four items for the project as a whole:

Hours per day
Days per week
Multiplication factor (for theft and damage)
Project start date
Project end date

Standard discipline tool lists are built into this spreadsheet. Click the following links if you wish to edit them:

Edit Boilermaker Tool List
Edit Civil Tool List
Edit Instrumentation/Electrical Tool List
Edit Millwright Tool List
Edit Piping Tool List
Edit Structural Steel Tool List
Edit Consolidated Tool List

Use the following links to access the outputs of this spreadsheet after all information has been input. Tool lists are available by discipline (by crew) or as a whole (consolidated).

Boilermaker Tool List
Civil Tool List
Instrumentation/Electrical Tool List
Millwright Tool List
Piping Tool List
Structural Steel Tool List
Consolidated Tool List

Figure A-2: Bottom of Navigation Page

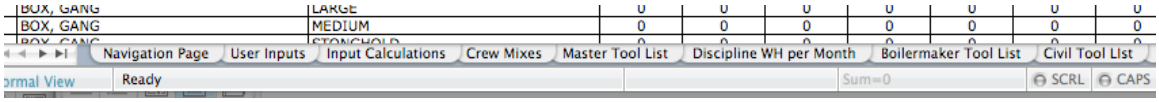


Figure A-3: Tabs for easy navigation

	A	B	C	D	E
1	Project name	Generic Piping Scenario			
2	Location	Clemson, SC			
3					
4	Discipline	Total work hours	Start date (mm/dd/yy)	End date (mm/dd/yy)	Distribution
5	Boilermaker	1000	10/1/09	1/1/10	Normal
6	Civil	1000	2/1/10	5/1/10	Normal
7	Instrumentation/Electrical	1000	5/1/10	7/1/10	Normal
8	Millwright	1000	8/1/10	1/1/11	Normal
9	Piping	1000	9/1/10	11/1/10	Normal
10	Structural Steel	1000	12/1/10	1/1/11	Normal
11	Hours per day	10			
12	Days per week	5			
13	Multiplication factor	1.5			
14	Project start date	10/1/09			
15	Project end date	1/1/11			
16					
17		Back to Navigation Page			

Figure A-4: User inputs sheet (user inputs shown in yellow)

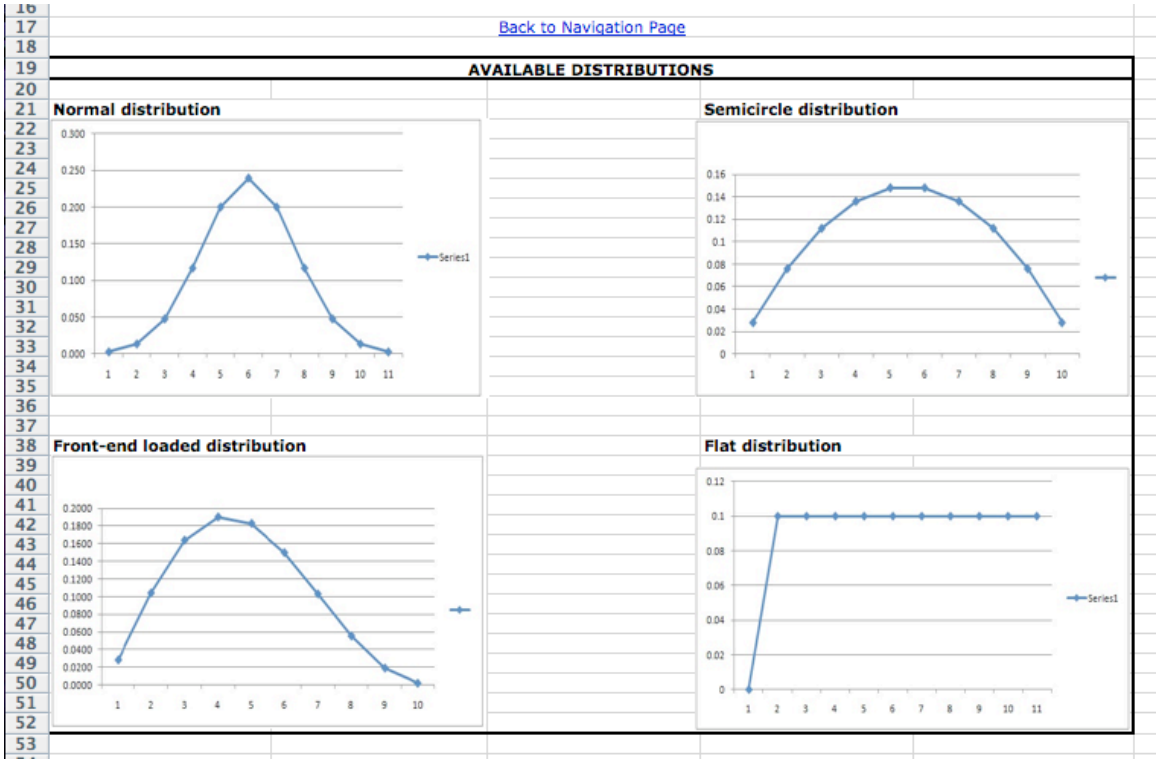


Figure A-5: The four available distributions

Item Number	Description 1	Description 2	Description 3	Number required, by discipline				
				Boilermaker	Civil	Insturmentation/Electrical	Millwright	Piping
00001	ADAPTER , SQ DRIVE	15/16"						
00002	ADAPTER, IMPACT SOCKET	1/2" FEMALE X 3/4" MALE						
00003	ADAPTER, IMPACT SOCKET	3/4" FEMALE X 1/2" MALE						
00004	ADAPTER, IMPACT SOCKET	3/4" FEMALE X 1" MALE						
00005	ADAPTER, IMPACT SOCKET	1" FEMALE X 3/4" MALE						
00006	ADAPTER, IMPACT SOCKET	1" FEMALE X 1-1/2" MALE						
00007	ADAPTER, IMPACT SOCKET	1-1/2" FEMALE X 1" MALE						
00008	AIR CONDITIONER / HEAT	11,400 BTU'S COOL	11,700 BTU'S HEAT					
00009	ARBOR, STARRETT	HOLE-SAW	38913			12		
00010	AX	3 1/2#						
00011	BAG	BOLT CANVAS						
00012	BAG	BURLAP	17" X 30"					
00013	BAG	STAKE						
00014	BAR	BRASS BUMPER	2"				5	
00015	BAR	BRASS BUMPER	3"				5	
00016	BAR, CROW , WRECKING	24"		5				
00017	BAR, CROW , WRECKING	36"						
00018	BAR, PINCH	48"		2				
00019	BAR, PINCH	60"		6				
00020	BAR, SPUD	24" HEX TYPE		6				
00021	BENDER, TUBING RIDGID .625	5/8" RATCHET TYPE						
00022	BENDER, TUBING RIDGID .75	3/4" RATCHET TYPE						
00023	BINDER, (1) CHAIN SMALL	SIZE 1-1/2 TON TO 2 TON						
00024	BINDER, CHAIN RATCHET	LOAD BINDER						
00025	BLANKET, RUBBER	HIGH VOLTAGE						
00026	BLANKET, WOOL							
00027	BLOCK, SNATCH	3" SINGLE SHEAVE	WIRE ROPE	4				
00028	BLOCK, SNATCH	4-1/2" SINGLE SHEAVE	WIRE ROPE	4				
00029	BLOCK, SNATCH	6" SINGLE SHEAVE	WIRE ROPE	4				
00030	BLOCK, SNATCH	8" SINGLE SHEAVE	WIRE ROPE	4				
00031	BLOCK, SNATCH	12" SINGLE SHEAVE	WIRE ROPE	4				
00032	BLOCK, SNATCH	4-1/2" DOUBLE SHEAVE	WIRE ROPE	4				
00033	BLOCK, SNATCH	6" DOUBLE SHEAVE	WIRE ROPE	4				
00034	BLOXIDE	ALUMINUM BLOXIDE	SPRAY					
00035	BOOK, FIELD							
00036	BOX, GANG	LARGE		5	5	5	2	10
00037	BOX, GANG	MEDIUM	25 CU.FT					
00038	BOX, GANG	STONGHOLD	48" W X 30" D X 30" H					
00039	BROOM, PUSH	24" WITH HANDLE	INDOOR / OUTDOOR					
00040	BROOM, STRAW							

Figure A-6: Sample of the Master Tool List

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1											Work hours per month, by discipline						
2		Boilermaker				Civil				Instrumentation/Electrical				Millwright			
3	Month beginning	Month BM	Percentage	WH	Crews	Month Civil	Percentage	WH	Crews	Month IE	Percentage	WH	Crews	Month MW	Percentage	WH	Crews
4	10/1/09	1	19.43%	194.28	0.88		0.00%	0	0		0.00%	0	0		0.00%	0	0
5	11/1/09	2	59.84%	598.41	2.72		0.00%	0	0		0.00%	0	0		0.00%	0	0
6	12/1/09	3	19.43%	194.28	0.88		0.00%	0	0		0.00%	0	0		0.00%	0	0
7	1/1/10	4	0.66%	6.6478	0.03		0.00%	0	0		0.00%	0	0		0.00%	0	0
8	2/1/10		0.00%	0	0	1	19.43%	194.3	0.88		0.00%	0	0		0.00%	0	0
9	3/1/10		0.00%	0	0	2	59.84%	598.4	2.72		0.00%	0	0		0.00%	0	0
10	4/1/10		0.00%	0	0	3	19.43%	194.3	0.88		0.00%	0	0		0.00%	0	0
11	5/1/10		0.00%	0	0	4	0.66%	6.648	0.03	1	48.39%	483.941	2.2		0.00%	0	0
12	6/1/10		0.00%	0	0		0.00%	0	0	2	48.39%	483.941	2.2		0.00%	0	0
13	7/1/10		0.00%	0	0		0.00%	0	0	3	0.89%	8.8637	0.04		0.00%	0	0
14	8/1/10		0.00%	0	0		0.00%	0	0		0.00%	0	0	1	5.40%	53.991	0.25
15	9/1/10		0.00%	0	0		0.00%	0	0		0.00%	0	0	2	24.20%	241.971	1.1
16	10/1/10		0.00%	0	0		0.00%	0	0		0.00%	0	0	3	39.89%	398.942	1.81
17	11/1/10		0.00%	0	0		0.00%	0	0		0.00%	0	0	4	24.20%	241.971	1.1
18	12/1/10		0.00%	0	0		0.00%	0	0		0.00%	0	0	5	5.40%	53.991	0.25
19	1/1/11		0.00%	0	0		0.00%	0	0		0.00%	0	0	6	0.44%	4.43185	0.02
20			0.00%	0	0		0.00%	0	0		0.00%	0	0		0.00%	0	0
21			0.00%	0	0		0.00%	0	0		0.00%	0	0		0.00%	0	0
22			0.00%	0	0		0.00%	0	0		0.00%	0	0		0.00%	0	0
23			0.00%	0	0		0.00%	0	0		0.00%	0	0		0.00%	0	0
24			0.00%	0	0		0.00%	0	0		0.00%	0	0		0.00%	0	0

Figure A-7: Sample of Discipline Work Hours per Month (calculation purposes only)

A	B	C	D	E	F	G	H	I	J	K	L
Project	Generic Piping Scenario										
Location	Clemson, SC										
Civil Tool List											
Values rounded up to the nearest whole number											
Item Number	**Description 1**	**Description 2**	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9
00036	BOX, GANG	LARGE	0	0	0	0	7	21	7	1	0
00232	CONCRETE	48" BULL FLOAT	0	0	0	0	4	13	4	1	0
00233	CONCRETE	6' BULL FLOAT HANDLE	0	0	0	0	4	13	4	1	0
00234	CONCRETE	FINISHING BROOM	0	0	0	0	4	13	4	1	0
00235	CONCRETE	JITTERBUG	0	0	0	0	4	13	4	1	0
00236	CONCRETE BRUSH		0	0	0	0	4	13	4	1	0
00237	CONCRETE EDGER	6" X 3"	0	0	0	0	4	13	4	1	0
00238	CONCRETE FLOAT	16" X 3-1/2"	0	0	0	0	4	13	4	1	0
00239	CONCRETE FLOAT	24" X 3-1/2" MAGNESIUM	0	0	0	0	3	9	3	1	0
00240	CONCRETE GROOVER		0	0	0	0	3	9	3	1	0
00241	CONCRETE RAKE		0	0	0	0	7	21	7	1	0
00242	CONCRETE SLUMP	CONE, PLATE, ROD	0	0	0	0	3	9	3	1	0
00245	COOLER, WATER	10 GALLON	0	0	0	0	27	82	27	1	0
00378	HAMMER, AIR	15# CHIPPING	0	0	0	0	14	41	14	1	0
00379	HAMMER, AIR	30# CHIPPING	0	0	0	0	14	41	14	1	0
00440	LEVEL	WOOD	0	0	0	0	3	9	3	1	0
00467	PICK	W / HANDLE	0	0	0	0	7	21	7	1	0
00478	PULLEY	WELL-WHEEL	0	0	0	0	3	9	3	1	0
00579	SAW, ELECTRIC	JIG	0	0	0	0	6	17	6	1	0
00774	STAMP, STEEL 1/4"	ALPHABETICAL	0	0	0	0	3	9	3	1	0
00775	STAMP, STEEL 1/4"	NUMERICAL	0	0	0	0	3	9	3	1	0
00813	VIBRATOR, CONCRETE	1"	0	0	0	0	6	17	6	1	0
00814	VIBRATOR, CONCRETE	ELECT. 1-1/2" HEAD	0	0	0	0	6	17	6	1	0
00824	WHEEL BARROW	2 WHEEL	0	0	0	0	8	25	8	1	0

Figure A-8: Populated tool list example, Civil Tool List

	A	B	C	D	E	F	G	H
1	Project	Generic Piping Scenario						
2	Location	Clemson, SC						
3	**Consolidated Tool List**							
4	*Values rounded up to the nearest whole number*							
5	**Item**							
6	**Number**	**Description 1**	**Description 2**	Month 1	Month 2	Month 3	Month 4	Mon
7	1	ADAPTER , SQ DRIVE	15/16"	0	0	0	0	0
8	2	ADAPTER, IMPACT SOCKET	1/2" FEMALE X 3/4" MALE	0	0	0	0	0
9	3	ADAPTER, IMPACT SOCKET	3/4" FEMALE X 1/2" MALE	0	0	0	0	0
10	4	ADAPTER, IMPACT SOCKET	3/4" FEMALE X 1" MALE	0	0	0	0	0
11	5	ADAPTER, IMPACT SOCKET	1" FEMALE X 3/4" MALE	0	0	0	0	0
12	6	ADAPTER, IMPACT SOCKET	1" FEMALE X 1-1/2" MALE	0	0	0	0	0
13	7	ADAPTER, IMPACT SOCKET	1-1/2" FEMALE X 1" MALE	0	0	0	0	0
14	8	AIR CONDITIONER / HEAT	11,400 BTU'S COOL	0	0	0	0	0
15	9	ARBOR, STARRETT	HOLE-SAW	0	0	0	0	0
16	10	AX	3 1/2#	0	0	0	0	0
17	11	BAG	BOLT CANVAS	0	0	0	0	0
18	12	BAG	BURLAP	0	0	0	0	0
19	13	BAG	STAKE	0	0	0	0	0
20	14	BAR	BRASS BUMPER	0	0	0	0	0
21	15	BAR	BRASS BUMPER	0	0	0	0	0
22	16	BAR, CROW , WRECKING	24"	7	21	7	1	0
23	17	BAR, CROW , WRECKING	36"	0	0	0	0	0
24	18	BAR, PINCH	48"	3	9	3	1	0
25	19	BAR, PINCH	60"	8	25	8	1	0
26	20	BAR, SPUD	24" HEX TYPE	8	25	8	1	0
27	21	BENDER, TUBING RIDGID .625	5/8" RATCHET TYPE	0	0	0	0	0
28	22	BENDER, TUBING RIDGID .75	3/4" RATCHET TYPE	0	0	0	0	0
29	23	BINDER, (1) CHAIN SMALL	SIZE 1-1/2 TON TO 2 TON	0	0	0	0	0
30	24	BINDER, CHAIN RATCHET	LOAD BINDER	0	0	0	0	0
31	25	BLANKET, RUBBER	HIGH VOLTAGE	0	0	0	0	0
32	26	BLANKET, WOOL		0	0	0	0	0
33	27	BLOCK, SNATCH	3" SINGLE SHEAVE	6	17	6	1	0
34	28	BLOCK, SNATCH	4-1/2" SINGLE SHEAVE	6	17	6	1	0
35	29	BLOCK, SNATCH	6" SINGLE SHEAVE	6	17	6	1	0
36	30	BLOCK, SNATCH	8" SINGLE SHEAVE	6	17	6	1	0
37	31	BLOCK, SNATCH	12" SINGLE SHEAVE	6	17	6	1	0
38	32	BLOCK, SNATCH	4-1/2" DOUBLE SHEAVE	6	17	6	1	0
39	33	BLOCK, SNATCH	6" DOUBLE SHEAVE	6	17	6	1	0
40	34	BLOXIDE	ALUMINUM BLOXIDE	0	0	0	0	0
41	35	BOOK, FIELD		0	0	0	0	0
42	36	BOX, GANG	LARGE	0	0	0	0	0

Figure A-9: Populated tool list example, Consolidated Tool List

APPENDIX B

INSTRUCTION GUIDE FOR SMALL TOOLS SPREADSHEET

Instruction Guide – Small Tools Spreadsheet

The Small Tools Spreadsheet is an Excel-based tool that takes standard discipline tool lists and distributes the correct amount of tools over the duration of a project with an appropriate distribution.

This document will serve as a concise set of instructions to use the Small Tools Spreadsheet. This guide, along with the guidelines on the Navigation Page within the spreadsheet itself, will educate users in the use of all aspects of the spreadsheet tool.

When the spreadsheet is first opened:

- Enable the built-in macros by clicking on the Security Warning and then Options. Click Enable Macros. This must be done each time the spreadsheet is opened.
- The spreadsheet opens to the Navigation Page. This page enables users to easily access all parts of the spreadsheet from a single location. Hyperlinks appear on every pertinent page of the spreadsheet.
- Users should carefully read and follow the instructions on the Navigation Page, especially if they have not used the spreadsheet before. Follow the Navigation Page from top to bottom and the spreadsheet can be completed easily.

Steps in filling out the spreadsheet:

1. Input the Project Name and Description by clicking on the first two hyperlinks that appear on the Navigation Page. Note that a link on the User Inputs sheet will jump back to the Navigation Page.
2. Work is divided into the following six disciplines: 1) Boilermaker, 2) Civil, 3) Instrumentation/Electrical, 4) Millwright, 5) Piping, and 6) Structural Steel. Input values for the following for all appropriate disciplines: total work hours, start date, end date, and appropriate distributions. The four distributions are shown on the bottom of the User Inputs sheet.
3. Input the following information for the project as a whole in the same manner as the discipline specific criteria were input: work hours per day, working days per week, multiplication factor (accounts for theft and damage), project start date, and project end date.
4. Standard tool lists for each discipline are provided (tools required for each crew). These values can be edited and the spreadsheet's calculations will adjust automatically. Edit them by clicking on the appropriate hyperlinks on the Navigation Page. If they are not edited, the standard built-in tool requirements will be used for the calculations.
5. When all the above information is filled in, the spreadsheet's outputs can be accessed. This can be done from the Navigation Page by clicking on the appropriate hyperlink. Outputs are available as tool lists (tools required each month) for each of the six disciplines or a consolidated tool list that sums the requirements for the entire project.

Figure B-1: Instruction Guide for Small Tools Spreadsheet